

Post-Delisting Monitoring Plan
For
Maguire Daisy
(*Erigeron maguirei*)



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Anti-Deficiency Act Disclaimer

Post-delisting monitoring is a cooperative effort between the Service, State, and Tribal governments; other Federal agencies; and nongovernmental partners. Funding of post-delisting monitoring presents a challenge for all partners committed to ensuring the continued viability of the Maguire Daisy (*Erigeron maguirei*) following removal of Endangered Species Act protections. To the extent feasible, the Service intends to provide funding for post-delisting monitoring efforts through the annual appropriations process. Nonetheless, nothing in this Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention to the Anti-Deficiency Act, 31, U.S.C. 1341, or any other law or regulation.

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I. Summary of the Roles of all Cooperators in the Post-delisting Monitoring Planning Effort

The Maguire daisy (*Erigeron maguirei*) is included in the Central Utah Navajo Sandstone Endemics Conservation Agreement and Conservation Strategy (herein after referred to as the Conservation Agreement and Strategy), a multi-year joint project by the Forest Service, Bureau of Land Management (BLM), Capitol Reef National Park (Capitol Reef NP), and the U.S. Fish and Wildlife Service (Service) (USDA et al. 2006). Signatories to this agreement include the Forest Service, Fishlake National Forest; BLM, Utah State Office; National Park Service, Capitol Reef NP; and the Service, Utah Field Office (USDA et al. 2006). The purpose of this agreement is to identify and meet the goals for long-term conservation of five rare endemic plants that occur on the Navajo Sandstone in central Utah, including Maguire daisy (USDA et al. 2006).

The Conservation Agreement and Strategy, which this document is modeled after, outlines the procedural provisions under which the federal agencies will be held accountable for future management of the Maguire daisy (USDA et al. 2006). In addition, the Conservation Agreement and Strategy documents the conservation actions needed to reduce or eliminate threats and to promote the conservation and perpetuation of the Maguire daisy (USDA et al. 2006). The specific actions required by each federal agency are described in further detail in **Section II. C. Legal and/or Management Commitments for Post-Delisting Conservation.**

II. Summary of Species Status at Time of Delisting

A. Demographic Parameters

The range of the species is currently estimated at 390 square miles (mi) (1,010 square kilometers (km)) and extends from the San Rafael Swell south through the Waterpocket Fold of Capitol Reef NP (Figure 1) (Heil 1987, Heil 1989, Kass 1990, Harper and Van Buren 1998, Clark 2001, Clark 2002, Clark et al. 2005, Clark et al. 2006). Maguire daisy has been located from 1,585 to 2,621 meters (m) (5,200 to 8,600 feet (ft)) in elevation (Clark et al. 2006). The highest plant densities occur on mesa tops between 1,829 and 2,134 m (6,000 and 7,000 ft) in elevation (Kass 1990, Service 1995, Clark 2001, Clark et al. 2006).

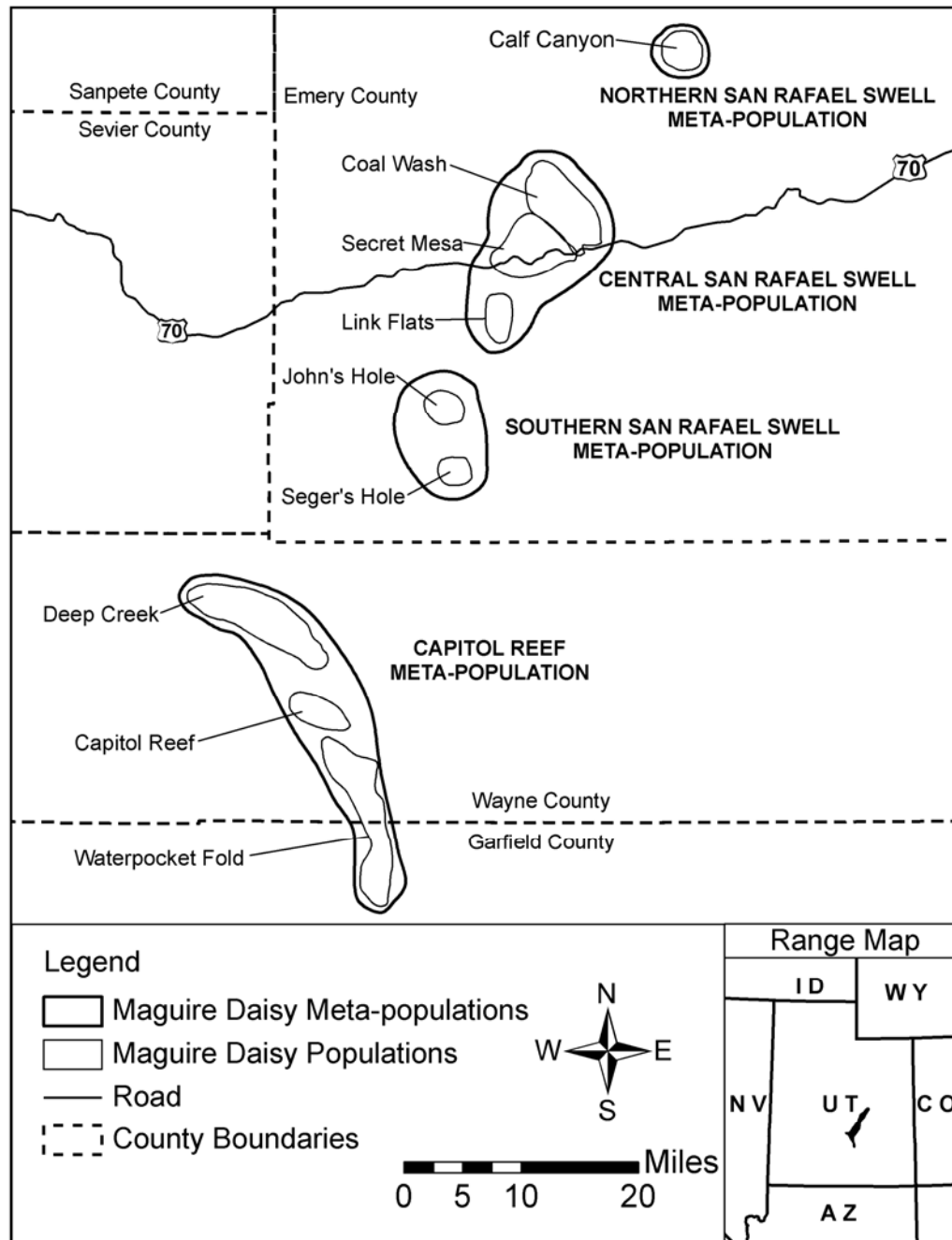


Figure 1. Maguire Daisy Range (Clark et al. 2006)

Based on recent survey information, there are 9 known populations (118 sites) within 4 meta-populations comprised of approximately 164,250 Maguire daisy individuals (Clark et al. 2006). The populations have been found to be sparsely distributed across the range (Clark 2006). The location of each of these populations is illustrated in Figure 1. Table 1 provides population size estimates, number of sites, and land ownership of each population.

Table 1. Population estimates (Clark et al. 2006, Ivory 2006).

Meta-Population	Population	Population Estimate	# of Sites	Land Ownership
Northern San Rafael Swell	Calf Canyon *	2,000	3	BLM (25 percent) / Utah State School and Institutional Trust Lands (SITLA) (75 percent)
Central San Rafael Swell	Coal Wash	100	6	BLM
	Secret Mesa	9,000	9	BLM
		1,000	2	SITLA
	Link Flats	200	4	BLM
		50	1	SITLA
Southern San Rafael Swell	John's Hole	300	3	BLM
	Seger's Hole	100	2	BLM
Capitol Reef	Deep Creek	1,500	2	Fishlake National Forest
		100,000	29	Capitol Reef NP
	Capitol Reef	30,000	15	Capitol Reef NP
	Waterpocket Fold	20,000	42	Capitol Reef NP
Total		164,250	118	

* The population estimate for this population is from 1980; current population is unknown.

Demographic monitoring studies suggest that the species is long lived, has a low mortality rate, and has the ability to replace individuals at a rate that compensates for mortality (Van Buren and Harper 2002). Overall, populations appear stable (Van Buren and Harper 2002).

B. Residual Threats

Over ninety-nine percent of the species populations occur on lands administered by Federal agencies. These populations have land designations that provide long-term protections for the plant. While potential future threats are present within the range of the species, none of these factors are thought likely to materialize within the foreseeable future. Even if some of these residual threats do materialize, the impact is expected to be limited to portions of populations. All noteworthy, foreseeable factors affecting the species status are discussed in the proposed rule to remove of the Maguire daisy from the Federal List of Endangered and Threatened Plants. To ensure impacts remain minor, Federal agencies plan to monitor a subset of the populations (as described in this plan) for at least ten years. If threats materialize, this should document their impact.

C. Legal and/or Management Commitments for Post-Delisting Conservation

The Conservation Agreement and Strategy outlines the procedural provisions under which the federal agencies will be held accountable for future management of the Maguire daisy (USDA et al. 2006). In addition, this Conservation Agreement and Strategy documents the conservation actions needed to reduce or eliminate threats and to promote the conservation and perpetuation of the Maguire daisy (USDA et al. 2006). The specific actions required by each federal agency are described in further detail below.

The Price Field Office of the BLM is responsible for inventorying the Calf Canyon population (USDA et al. 2006). The BLM is to determine the number of individuals and the overall distribution within this population in order to verify this previously known occurrence (USDA et al. 2006). All agencies are to develop and implement a survey plan for suitable habitats that remain to be surveyed within the area covered by the Conservation Agreement and Strategy (USDA et al. 2006).

BLM, Capitol Reef NP and the Fishlake National Forest will establish and conduct population trend monitoring studies from fiscal year 2007 through fiscal year 2017 (USDA et al. 2006). If monitoring detects a decline at any of the sites, then monitoring would shift to either a more intensive protocol for determining trend, or include additional sites of population trend monitoring for a minimum of three years to determine if the initial decline noted is accurate (USDA et al. 2006).

The BLM Price Field Office may establish and conduct impact monitoring studies for the populations in the Coal Wash, Secret Mesa, and Link Flats areas to determine whether motorized and non-motorized recreational activities impact the species (USDA et al. 2006). If Calf Canyon is determined to be extant, then monitoring would be done there as well (USDA et al. 2006).

The federal land agencies will continue to implement management plans to conserve Maguire daisy and their habitats and to ensure that actions authorized, funded, or carried out by the agencies would not contribute to the listing of a species (USDA et al. 2006). The BLM and Fishlake National Forest will adjust surface disturbance locations to avoid the Navajo endemics, including Maguire daisy, for Discretionary and Leasable Minerals (USDA et al. 2006). The BLM and Fishlake National Forest will not identify lands containing Navajo endemics, including Maguire daisy, for disposal or exchange (USDA et al. 2006). All federal agencies will work towards acquiring private and state lands that contain Navajo endemics, including Maguire daisy (USDA et al. 2006).

The federal agencies will work together to protect Maguire daisy from commercial exploitation and illegal collection (USDA et al. 2006). This includes developing surveillance techniques to monitor at risk occurrences (USDA et al.

2006). The BLM and Capitol Reef NP will implement surveillance at potential collection sites for Maguire daisy (USDA et al. 2006). Maguire daisy will be evaluated to determine whether it meets the criteria for listing in Appendix I, II, or III of the Convention of International Trade in Endangered Species of Fauna and Flora (USDA et al. 2006). If the Maguire daisy meets the criteria, it will be petitioned by the Service for inclusion on the list (USDA et al. 2006). All federal agencies will work with the federal law enforcement staff in Maguire daisy's range to ensure applicable regulations are enforced (USDA et al. 2006).

Capitol Reef NP, Fishlake National Forest, and the BLM Price Field Office would pursue funding to establish a Center for Plant Conservation endowment for Maguire daisy (USDA et al. 2006). Maguire daisy is currently covered by the Flagstaff Arboretum for seed collection and storage (USDA et al. 2006). The endowment may also include establishment of germination and propagation trials for the purpose of maintaining genetic conservation and research into techniques necessary for establishing additional occurrences in suitable habitat (USDA et al. 2006).

The Service, Capitol Reef NP, BLM Price Field Office, and Fishlake National Forest will develop new partnerships and continue their educational programs to increase public awareness of Maguire daisy (USDA et al. 2006).

III. Selecting Monitoring Type and Locations

This section outlines a method for selecting monitoring sites for Maguire daisy on Capitol Reef NP, BLM administered lands (Price Field Office area), and Fishlake National Forest. The monitoring protocols are based on the draft Northern Colorado Plateau Inventory and Monitoring Protocols (Fertig et al. 2005).

A. General Strategy for Prioritizing Monitoring of Populations

Figure 2 illustrates a general strategy for determining which monitoring approach (e.g., presence/absence, population trend, habitat condition, or demographic) is most appropriate for a given occurrence based on information gaps, trends, threats, and population size.

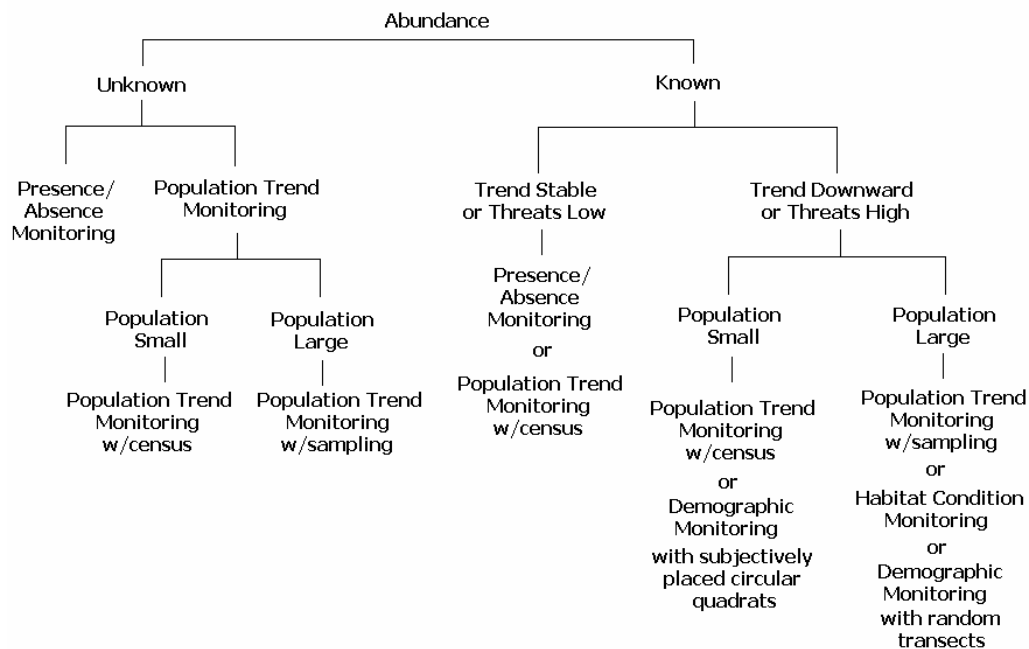


Figure 2. Decision tree diagram for selecting the appropriate monitoring strategy for rare plant population clusters and individual sites (Fertig et al. 2005).

The following rules are recommended for selecting specific sites for monitoring based on that strategy:

1. Sites with poor or inadequate baseline abundance or location data should be a priority for presence/absence or population trend monitoring. Presence/absence inventories are especially suited for sites that have not been successfully relocated in 10 or more years and may no longer be extant. Occurrences that are known to be present, but lack good population estimates are a high priority for quantitative population trend analysis. If sites are relatively small (less than 1 acre with well-defined habitat boundaries) full population census may be possible, but in other cases sub-sampling with macro plots or transects will be more efficient.
2. Population clusters and sites with adequate baseline abundance data that have a stable trend or minimal threats should be a priority for presence/absence monitoring. These locations may not need to be revisited as frequently as more threatened or declining occurrences. Should the population size decline sharply or threats increase, these sites should be considered a high priority for more frequent and detailed monitoring techniques.

3. Population clusters and sites with adequate baseline data that have downward trends or high threats are a priority for quantitative population trend, habitat condition, and demographic monitoring. The appropriate form of monitoring in these situations will be influenced by the size and extent of the occurrence.
 - a. For sites less than 1 acre in size, complete population censuses may be possible. Habitat condition can be determined through qualitative means (in conjunction with the population census form) rather than through more formal, plot-based monitoring. Intensive demographic monitoring (with randomly placed belt transects) is not recommended for small or widely dispersed populations, but useful demographic data can still be developed using stratified circular quadrats. Tagging individual plants, determining size class, and documenting longevity, mortality, and recruitment over time will help develop needed baseline life history data for these sites, though the results of these studies will be less suited for extrapolation to the entire population than comparable research at larger populations with randomly selected plots.
 - b. For sites over 1 acre in size, trend studies should employ macro plot-based sampling for greater efficiency and to reduce the likelihood of undercounting. Depending on population density and site fragility, however, macro plot or transect locations may need to be stratified or have less replication than needed for optimal statistical analysis and extrapolation in order to minimize impacts to plants and their habitat. Quantitative habitat condition sampling may be more appropriate for large populations and can be done in sites immediately adjacent to macro plots established for population trend sampling (so as to reduce potential trampling impacts). At least one large site per population should be selected for demographic monitoring using randomly placed belt transects. Large occurrences are better suited for more formal demographic monitoring than smaller sites because a larger pool of individuals is available for study and more randomization can be incorporated into the design. As with population trend monitoring however, the requirements for randomization and sufficient replication may need to be modified in situations where trampling impacts from monitoring may be excessive.

B. Monitoring methods selected for Maguire Daisy

Because there is either insufficient data on abundance at sites or sites are presumed to be stable, population trend with census monitoring was selected as

the initial monitoring method for all sites. After two years of data are available, data will be analyzed to determine whether there has been any change in population levels. If a site shows a decline of 40% or more within a two year period, two additional sites within the affected population will be added to the monitoring scheme. This percent of decline was selected based on data gathered by Van Buren and Harper (2002) during her demographic monitoring of this species. They stated that this species is relatively long-lived and her monitoring showed it to have fairly stable populations. Mortality rates fluctuated between 7% and 13% over an average of three years at four sites, with the highest annual mortality at one site being over 20%.

The two randomly selected additional sites will be monitored using the same population trend with census monitoring method for at least two years to determine whether the decline is occurring throughout the population. During this time monitoring at the initial site would continue. If additional monitoring shows the decline within that population is continuing, then more intensive investigations such as demographic monitoring and research to determine cause of decline would be initiated.

If population trends appear stable or are increasing over a period of five years, monitoring methods may be continued but monitoring frequency may be reduced. After five years of monitoring following protocols stated in this report, all available data on this species will be reviewed to determine whether there are any data gaps that need to be addressed. If significant data gaps are found, managers would determine whether a demographic monitoring plot or additional monitoring plots using population trend with census monitoring would be valuable. If deemed necessary, a new demographic monitoring plot would be established or one of Van Buren's sites would be reestablished.

To better understand whether human impacts at specific Maguire daisy sites threaten the stability of this species, a review of all site locations containing more than 50 plants will be done to determine presence of human impacts. These sites will be visited and extent of human impacts evaluated. If human impacts are found, the level of impact would be recorded and monitoring initiated.

C. Selecting Populations for Monitoring

Randomly selected sites within each of the nine populations described in the Maguire Daisy (*Erigeron maguirei*) Status Report (Clark et al. 2006) would be monitored for changes in population size, density, and other attributes. Populations are defined as groups of occurrence records (sites) located in the same geographic vicinity. The nine populations were grouped into four meta-populations. A meta-population is comprised of a number of individual populations linked by continuous suitable habitat. The general locations of known populations and meta-populations are shown in Figure 1. Sites are defined

as occurrence locations recorded by one or more researcher over time. Every site is documented by at least one of the following: 1) a herbarium collection record, and/or, 2) field survey forms completed by researchers, and/or, 3) a record from the Utah Natural Heritage Program.

How sites are chosen for monitoring within each population has important ramifications for the type of inferences managers can derive from their data. Only sites chosen at random from all available sites in each population (with each having an equal probability of being selected) can be used to make inferences to the entire population of interest. Sites selected subjectively may still yield useful information (particularly for high profile or high risk populations), but those data cannot be extrapolated to other areas.

Random selection from the entire range of the species can, by chance, result in sites being selected from the same approximate location, or same general habitat and management. This may be problematic for those species occurring over wider geographic areas and a mix of habitats and land ownerships. Stratification procedures can be used to subdivide all available sites into smaller, more natural groups, each of which can then be subjected to randomized selection. Typically, stratification is done according to patterns of geography, elevation, habitat, and land ownership, but can also be done based on data gaps, degree of threat, trends, and population size. Stratified random sampling helps ensure that a wider array of sites is chosen for monitoring than would be possible by random chance alone.

D. Procedures

One site per population would be monitored for population trend using census counts. This monitoring would determine general population trends over time. Human impacts (if present) at each site would be recorded and monitored. This monitoring would determine whether human impacts are stable or increasing and whether impacts pose a threat to the population.

A list of specific Maguire daisy sites within each population is included in this document. During the site selection process, it is recommended that two sites be randomly selected from each population. One site will be the first choice for monitoring, and the second site will be considered a “backup site” to be used only if for some reason the first site is not acceptable. Reasons that a site is deemed not acceptable include too difficult to access on a regular basis, habitat too fragile for repeated monitoring visits, or an insufficient number of plants found during plot selection reconnaissance. For the initial monitoring locations, only sites containing a minimum of 50 plants will be considered for selection.

Four of the populations (Johns Hole, Seger’s Hole, Link Flats and Coal Wash) contain only one or two known sites with more than 50 plants. If additional sites are needed within these populations due to 40% or greater decline at the initial

polygon site, these may be randomly selected from the entire list of known sites including those that contain fewer than 50 plants.

E. Discussion of Populations

1. The Calf Canyon population is the northern and eastern-most known population and contains the type locality. It is located on Bureau of Land Management and State of Utah lands on the Bottleneck Peak and Bob Hill Knoll, UT, 7.5 min quadrangles. The last recorded visit was by J. Anderson in June of 1982. The population occurs between 5,500 and 5,800 feet elevation, and in the 1980's was reported to contain approximately 2,000 plants from three sites. Two of the three sites are on State of Utah lands. The area needs to be revisited to determine whether this population is still extant. Once this is done and if the population is still extant, population trend with census monitoring would be initiated. Human impact monitoring may also be needed at one site in the population if impacts are present.
2. The John's Hole population is located on the Ireland Mesa, UT, 7.5 min quadrangle on Bureau of Land Management lands. It was found in May 2001 by the Interagency Rare Plant Team. The population occurs between 6,238 and 6,275 feet elevation, and contains about 300 plants from three sites. The John's Gateway site contained more than 50 plants. The other three sites contained less than 50 plants. Since these sites have only been visited and recorded once, there is inadequate abundance data. If the population is still extant, population trend with census monitoring would be initiated. Human impact monitoring may also be needed at one site in the population if impacts are present.
3. The Seger's Hole population is located on the Frying Pan, UT, 7.5 min quadrangle on Bureau of Land Management lands. It was found in May 2002 by the Interagency Rare Plant Team. The population occurs between 6,400 and 6,497 feet elevation, and contains approximately 100 plants from 2 sites. The Below Seger's Overlook site contained more than 50 plants. The other site contained less than 50 plants. Since these sites have only been visited and recorded once, there is inadequate abundance data. If the population is still extant, population trend with census monitoring would be initiated. Human impact monitoring may also be needed at one site in the population if impacts are present.
4. The Link Flats population is located on the Copper Globe, UT, 7.5 min quadrangle on Bureau of Land Management and State of Utah lands. It was last visited by Ron Kass in June 1990. The population occurs between 6,000 and 7,000 feet elevation and contained about 200 plants from five sites in 1990. R. Kass' Sagebrush Bench and Lucky Strike Mine sites are the only two sites with approximately 50 plants reported. The other three sites

contained less than ten plants at the time of the last visit. Since these sites have only been visited and recorded twice, there is inadequate abundance data. If the population is still extant, population trend with census monitoring would be initiated. Human impact monitoring may also be needed at one site in the population if impacts are present.

5. The Coal Wash population is located on The Blocks, UT, 7.5 min quadrangle on Bureau of Land Management. It was last visited by Ron Kass in June 1990. The population occurs between 5,980 and 7,220 feet elevation and contained about 100 plants from six sites in 1990. R. Kass' site at Devil's Racetrack is the only site known in this population to contain more than 50 plants. This site is located at approximately 7,000 feet elevation. The other four sites reported contained less than 25 plants at the time of the last visit. Since these sites have only been visited and recorded twice, there is inadequate abundance data. If the population is still extant, population trend with census monitoring would be initiated. Human impact monitoring may also be needed at one site in the population if impacts are present.
6. The Secret Mesa population is located on the Sid and Charley, The Blocks, Copper Globe, and San Rafael Knob, UT, 7.5 min quadrangles on Bureau of Land Management and State of Utah lands. It was last visited by the Interagency Rare Plant Team in May 2002. Van Buren and Harper (2002) had two demographic monitoring plots located in this population. The population occurs between 6,560 and 7,100 feet elevation, and contains approximately 10,000 plants from 11 sites. The Arch Cove site contains over 100 plants. R. Kass' Justensen Flats/Devil's Canyon and South Fork Coal Wash sites each contain over 100 plants. The other four sites reported contained less than 25 plants at the time of the last visit. This population has adequate baseline abundance and location data. So, following suggestion 2 above, population trend with census monitoring could be done in this population. Human impact monitoring may also be needed at one site in the population if impacts are present.
7. The Deep Creek population is located on the Flat Top, Cathedral Mountain and Fruita, UT, 7.5 min quadrangles on Capitol Reef National Park and Fishlake National Forest. It was last visited by the Interagency Rare Plant Team in June 2001. The population occurs between 5,875 and 8,600 feet elevation, and contains approximately 100,000 plants from 31 sites. The following sites located by the Interagency Rare Plant Team contain over 100 plants: Lunch, Garden of Gilia, Above Paradise Flats, Between Dome, Voices Dome, Straight Flush, Rodney's Find, Nava Toes, Black widow Pour Off, Hilltop Parsley, Little Sand Flat East and Above Little Sand Flat East. All sites are difficult to access. This population has adequate baseline abundance and location data. So, following suggestion 2 above, population trend with census monitoring could be done in this population. Human impact

monitoring may also be needed at one site in the population if impacts are present.

8. The Capitol Reef population is located on the Twin Rocks and Fruita, UT, 7.5 min quadrangles in Capitol Reef National Park. One site in this population was last visited by the Interagency Rare Plant Team in September 2005. Van Buren and Harper (2002) had two demographic monitoring plots located in this population. The population occurs between 5,200 and 6,560 feet elevation, and contains approximately 30,000 plants from 14 sites. Four sites located by the Interagency Rare Plant Team contained more than 50 plants; Navajo Knobs #1, Navajo Knobs #2, Longleaf Flats and 24 Karat Pass. Two other sites visited by multiple researchers contained over 50 plants; Grand Wash and Hickman Bridge. This population has adequate baseline abundance and location data. So, following suggestion 2 above, population trend with census monitoring could be done in this population. Human impact monitoring may also be needed at one site in the population if impacts are present.
9. The Waterpocket Fold population is located on the Golden Throne, Sandy Creek Benches and Bear Canyon UT, 7.5 min quadrangles on Capitol Reef National Park. It was last visited by the Interagency Rare Plant Team in June 2002. The population occurs between 5,280 and 6,852 feet elevation, and contains approximately 20,000 plants from 42 sites. The following Interagency Rare Plant Team sites contained over 50 plants: Fern's Route, Dance Floor, Blue Notch Overlook, Little Arches, Burrito Wash, Pool View, Bench Above Pools, Navajo Heaven, Five Mile Dome, Ponderosa Basin, Moose Marbles, North Oak Creek #1, and North Oak Creek #2. This population has adequate baseline abundance and location data. So, following suggestion 2 above, population trend with census monitoring could be done in this population. Human impact monitoring may also be needed at one site in the population if impacts are present.

IV. Conducting Population Trend with Census Monitoring

This section outlines a consistent procedure for conducting population trend with census monitoring for Maguire daisy sites following techniques used by the network of Natural Heritage Programs (under the umbrella of NatureServe, formerly a subsidiary of The Nature Conservancy) and the Interagency Rare Plant Team. These protocols are based on the draft Northern Colorado Plateau Inventory and Monitoring Protocols (Fertig et al. 2005).

A. Site Selection

The following is a discussion of each population and the sites known to contain more than 50 plants. This list of sites will be used to randomly select the initial monitoring locations within each population.

1. Calf Canyon population: The area needs to be revisited to determine whether this population is still extant. Once this is done, and if the population is still extant, population trend with census monitoring would be initiated at one of the larger populated sites.
2. John's Hole population: The Interagency Rare Plant Teams' John's Gateway site contained more than 50 plants. The other three sites contained less than 50 plants.
3. Seeger's Hole population: The Interagency Rare Plant Teams' Below Seeger's Overlook site contained more than 50 plants. The other sites contained less than 50 plants.
4. Link Flats population: R. Kass' Sagebrush Bench and Lucky Strike Mine sites are the only two sites with approximately 50 plants reported. Other sites contained less than ten plants at the time of the last visit.

There is a potential for selecting one of these sites for motorized and non-motorized impact monitoring. Data on ATV route compliance would be reviewed prior to the initial field monitoring season. During the initial year of monitoring, field staff should determine whether it is possible for ATV traffic to access any of the sites and whether there is potential for motorized vehicle impacts.

5. Coal Wash population: R. Kass' site at Devil's Racetrack is the only site known in this population to contain more than 50 plants and is located at approximately 7,000 feet elevation. Other sites reported in this population contained less than 25 plants at the time of the last visit. There is an open ATV route that goes near the site, so during the initial year of monitoring, field staff should determine whether it is possible for ATV traffic to access any of the sites, and whether there is potential for motorized vehicle impacts.
6. Secret Mesa population: The Interagency Rare Plant Team's Arch Cove site contains over 100 plants. R. Kass' Justensen Flats/Devil's Canyon site contains over 100 plants, and his South Fork Coal Wash site contains 100-1000 plants. Other sites reported contained less than 25 plants at the time of the last visit.

There is a potential for selecting one of these sites for motorized and non-motorized impact monitoring. Data on ATV route compliance would be

reviewed prior to the initial field monitoring season. During the initial year of monitoring, field staff should determine whether it is possible for ATV traffic to access any of the sites, and whether there is potential for motorized vehicle impacts.

7. Deep Creek population: The following sites located by the Interagency Rare Plant Team contained over 100 plants: Lunch, Garden of Gilia, Above Paradise Flats, Between Dome, Voices Dome, Straight Flush, Rodney's Find, Nava Toes, Black widow Pour Off, Hilltop Parsley, Little Sand Flat East and Above Little Sand Flat East.
8. Capitol Reef population: Four of the Interagency Rare Plant Teams sites contained more than 50 plants; Navajo Knobs #1, Navajo Knobs #2, Longleaf Flats and 24 Karat Pass. Two other sites visited by multiple researchers contained over 50 plants; Grand Wash and Hickman Bridge.
9. Waterpocket Fold population: The following Interagency Rare Plant Team sites contained over 50 plants: Fern's Route, Dance Floor, Blue Notch Overlook, Little Arches, Burroito Wash, Pool View, Bench Above Pools, Navajo Heaven, Five Mile Dome, Ponderosa Basin, Moose Marbles, North Oak Creek #1, and North Oak Creek #2.

Due to the difficulty in accessing many of these sites, it will take approximately 2 to 2 ½ weeks to complete population trend with census monitoring and determine what sites have human impacts at each of the nine sites (one site per population). The most efficient way to accomplish these tasks is with a week long campout in the northern portion of the range and a two day campout in Capitol Reef National Park. This time estimate does not include time required to conduct human impact monitoring at the any of the selected sites. This monitoring, once determined necessary, would probably take one day per site (including travel time to site). Therefore, the final estimate of time for all monitoring would be approximately three weeks for two people. Monitoring should be conducted in June when plants are in full bloom. Sites located at lower elevations should be monitored first to ensure that the majority of plants are in full bloom at time of monitoring.

B. Sites Selected for Population Trend with Census Monitoring

In May 2006, sites containing more than 50 plants in eight of the above noted populations (Calf Canyon Population excluded) were identified for random selection. Two sites with more than 50 plants per population (if two sites existed) were randomly selected. The following list reports sites randomly selected for population trend with census monitoring by population.

1. Calf Canyon population: no site selected until population found to be extant.

2. John's Hole population: The Interagency Rare Plant Teams' John's Gateway site (only one site).
3. Seeger's Hole population: The Interagency Rare Plant Teams' Kyle's Find site (only one site).
4. Link Flats population: R. Kass' Sagebrush Bench site (only one site).
5. Coal Wash population: R. Kass' Devil's Racetrack site (only one site). Monitoring polygon established and initial census count conducted at the Devil's Racetrack site in FY 2006.
6. Secret Mesa population: R. Kass' Justensen Flats/Devil's Canyon site is first choice; The Interagency Rare Plant Team's Arch Cove site is the second choice. Monitoring polygon established and initial census count conducted at the Justensen Flats site in FY 2006.
7. Deep Creek population: Lunch is first choice; Nava Toes is second choice. Both these sites are ones located by the Interagency Rare Plant Team. Monitoring polygon established and initial census count conducted at the Lunch site in FY 2006.
8. Capitol Reef population: Interagency Rare Plant Team Navajo Knobs #1 site is first choice; Grand Wash is second choice. Monitoring polygon established and initial census count conducted at the Navajo Knobs #1 site in FY 2006.
9. Waterpocket Fold population: Interagency Rare Plant Team Burroito Wash site is first choice; 5 Mile Dome is second choice. Monitoring polygon established and initial census count conducted at the Burroito Wash site in FY 2006.

C. Site Documentation and Plot Establishment

1. The above list of sites by population was compiled by consulting existing databases, photo libraries, staff experts, and previous survey or inventory reports. This information gave baseline population numbers, approximate distribution and density of the population, habitat attributes, and other data that would facilitate location of monitoring sites.
2. Sites were randomly selected to be inventoried for population trend with census information from sites determined by the above process. Determine location and GPS coordinates (if available) of target sites from existing databases and maps. Develop an itinerary to most efficiently visit the most sites within the allotted time available.

3. Navigate to the coordinates or location of the selected site using the detailed directions from the site database.
4. Once a site has been relocated, confirm that the target plant species is present. Take photographs of the plant for documentation. Include a laminated photo board in the photo if possible indicating the species name, date, survey site (site ID #), and other relevant notes within the frame of the picture.
5. Spend time investigating the site by hiking through the area to determine a reasonable polygon boundary, potential for habitat impacts due to trampling by surveyors, and to get a sense of population density and distribution. Use a GPS unit to mark your track as you walk through the area and use the waypoint feature to mark where individual plants occur. While at the site, determine a realistic number of person hours required to adequately walk parallel transect lines spaced approximately one to two meters apart through a selected polygon area. Note this time on the field form as the standard survey time to be used at each site.
6. After exploring the site complete a Site Visit Account (SVA) Form.
7. Take a minimum of four additional photos of the polygon site to document the physical location (ideally with a permanent or easily-recognizable physical landmark for a reference point), to show natural and unnatural impacts (if any), and to show the habitat. Record the compass orientation of each photo and other pertinent information. At least two photos should be taken while standing at the permanent plot point. Photographers should take photos in several different directions to illustrate as much of the polygon as possible.
8. After collecting GPS data, determine the best size, shape and location of a polygon for census monitoring. Describe polygon boundaries on field forms and select a permanent relocation (rebar) point for the polygon. Take photographs to illustrate polygon boundaries and describe them very specifically on the field forms. At the appropriate easily relocated point, hammer an 18 inch rebar into the ground, leaving approximately 8-10 inches visible above ground. An aluminum tag with the plot number can be wired to the rebar. GPS and photograph the location of this permanent rebar marker. (Note: Navajo sandstone outcrops tend to have very easily defined boundaries where the stone ends and sandy wash or bottom land begins. Therefore, delineating boundaries for these plots has been very straight forward.)
9. For sites that occur on large outcrops of Navajo Sandstone with no discernable polygon boundary, surveyors may chose to use a large circle to encompass the monitoring site. The circle center should be selected within or adjacent to a dense cluster of plants. Circle diameter can be variable but should be selected to include a minimum of 100 plants.

10. Once the polygon/circle boundary has been delineated, surveyors would walk transect lines through the polygon to collect population and size class information on every individual plant found. Generally, teams will walk parallel lines spaced approximately one to two meters apart. Surveyors will record number of individuals by size class with electronic tally counters that allow each size class to be recorded separately. Simultaneously, surveyors will GPS each individual plant recorded. This dual recording system will be repeated every year.
 - a. Seedling- Juvenile – First year plant less than 1/4 expected diameter or height of mature plants and without buds, flowers, or fruits; basal rosette of leaves without a woody base
 - b. Vegetative mature – Full or nearly full-sized individual without buds, flowers, or fruits; plant has a woody taproot, but may be only a basal rosette or it may have multiple stems
 - c. Reproductive mature – Full or nearly full-sized individual with buds, flowers, or fruits
 - d. Dead – non-living individual in any size class
11. On the “Population Census” form, enter the actual number of plants counted by size class and total number of plants in the polygon.
12. Care must be taken to ensure that smaller plants (especially seedlings) are not under-counted. In addition, surveyors need to be sure that individual plants can be distinguished, especially in situations where plants may be clustered. For rhizomatous plants, number of stems may have to serve as a surrogate for number of individuals, as ramets (branches from the same genetic individual) may be indistinguishable from genets (genetically distinct individuals).
13. If necessary, accuracy of census counts can be increased by subdividing the site into smaller grids or belts. Two or three 50 meter tapes may be laid out in parallel lines 2-3 meters (or more) apart can form belts that can be easily surveyed by one or two observers employing a zig-zag or meandering route. Alternatively, flagging may be placed along parallel lines as surveyors walk the polygon. Using grids, belts or flagging helps ensure that field surveyors do not miss plants or do not count the same ones twice. Natural barriers can also be used to designate subunits for censusing.
14. The Interagency Rare Plant Team SVA field form should have been completed during the reconnaissance visit to establish the monitoring plot. This form requires detailed information on habitat, biology, individual plant vigor, presence of herbivory, identification, hybridization (if present), and conservation. For each successive year of monitoring, the field staff would take this completed SVA form into the field for reference. The habitat condition and conservation portions of the form would be completed annually.

There are specific field population trend with census and human impact photo point monitoring forms to be completed each year at each site.

15. Return to the office and download GPS files into a GIS project. Create a map from the downloaded GPS locations of both tracking and waypoints points overlain onto a 1:24,000 scale topographic map to depict site size, location, and areas of highest individual plant occurrences. Determine and record accurate acreage of polygon on field forms. This map will help surveyors relocate the polygon in following years as well as will help illustrate the polygon boundary.
16. Sites should be monitored annually for a period of five years. At this time, land management agencies should review the analyzed data for each site to determine if this type of monitoring should be continued and to decide whether the monitoring frequency or intensity needs to be changed. This determination should be made on a site-by-site basis.

Having a permanently marked site enables the field staff to know precisely what area is covered within each site. This information, in conjunction with the tally of plants by area, gives an estimate of plant density per site. Each successive annual visit would utilize the polygon map and monitoring time frame from the previous year to determine the time required and area to be covered for the current years' monitoring. This technique ensures a level of repeatability year to year regardless of who does the monitoring. Once monitoring plots are established, the time required to conduct annual monitoring is very reasonable.

E. Data Analysis

1. Enter data from current year's population trend monitoring into the appropriate fields of a computerized Maguire daisy monitoring database.
2. For each site, calculate the total number and percentage of individuals in each life stage class. Calculate density by life stage class for the entire site by summing the total number of plants in each group and dividing by the area of the site.
3. After collecting annual data (from the second year onward), determine the mortality rate by site. If the mortality rate at any site is greater than 40% within a two year period, discuss the need for establishing additional monitoring sites in that population with land managers. Follow above reported protocols for initiating additional monitoring polygons.
4. After five years of data are available, plot the number of plants in each size class by site and population to create a graph depicting population change. Review the graph for large fluctuations in estimated population size,

especially for significant decreases in total numbers or in the numbers of individual life history stage classes. If levels of change appear and raise concerns, consider developing more specific monitoring questions and applying more rigorous monitoring methods, such as demographic monitoring. If population trends appear stable or are increasing over this period of several years, consider continuing population trend with census monitoring but adjust the frequency of monitoring to every 2 to 3 years rather than annually.

V. Conducting Human Impact Monitoring

This section describes techniques applicable for measuring changes in environmental conditions from human impacts in occupied rare plant habitat. Early detection of changes in habitat quality can be critical for implementing appropriate management changes in a timely fashion. Habitat management through manipulation of land uses may be the best tool managers have at their disposal to promote the survival or recovery of rare plant species. Caution must be taken, however, in recognizing habitat trends that are the result of short-term fluctuations and cycles within the realm of natural variation versus those that represent novel or unidirectional negative changes.

Human impact monitoring would be conducted at some of the sites when impacts are occurring to plants. Descriptive habitat summaries as outlined in the Site Visit Account forms would be completed annually and permanent photo points would be established.

A. Photo points

Permanent photo points provide a visual record of environmental conditions (amount of vegetative cover, bare soil, degree of herbivory, proliferation of roads, etc.) that can depict gross changes when repeated at the same location over many years. Photo points are also useful for documenting the location of permanent transects and macro plots (Elzinga et al. 1998). Record all information from the following steps in the “Photo Documentation” form (Appendix A).

B. Procedures

1. Use permanent marker or rebar at the site from which to take landscape photos depicting the location of a plot and human impacts. Record the orientation of the photo (e.g., degrees from North).
2. Use a standard height from which photos would be taken at each return visit. A tripod (if used) will ensure a standard height and reduce blurriness resulting from an unsteady photographer (especially critical in low-light situations).

3. Use a photo board to document the site and subject of the photo (Appendix A).
4. Take multiple frames of the same view using different exposures to ensure at least one will come out.
5. For landscape shots, include enough horizon and distinguishing features to ensure the site can be relocated.
6. Take photos from previous years' inventory to compare changes in habitat. Make note of any changes on field form.
7. If any human impacts are noted at the site, GPS their location and extent. For example, if there is an ATV track running through the site, use a GPS unit to mark its location and the extent of the track through the site. Note on forms whether the track is recent or old, well used or a one time pass over the landscape. If an old campsite or trash piles are found within the site, GPS a point marking their location, and note extent of these disturbances on the forms. If there are human footpaths or cattle trails, GPS their location and record the extent and time frame (recent or old) of these disturbances on forms. Record and GPS any other unnatural disturbances found at the site.

VI. Definition of Thresholds/Triggers for Potential Monitoring Outcomes and Conclusions

Annual reports summarizing the activities, data collected, and results of each component of the PDM plan should be submitted by the cooperators to the Utah Field Office of the Service. These reports must be prepared and reviewed in a timely manner to ensure that adequate data are being collected, to allow evaluation of the efficacy of the monitoring programs and their modification, if necessary, and to allow periodic assessment of the status of the Maguire daisy. Each annual report will synthesize all monitoring data including population trend and comment on the status of the Maguire daisy relative to the need for relisting.

A monitoring program and its methodologies are described in the sections **III Selecting Monitoring Type and Locations**, **IV Conducting Population Trend with Census Monitoring**, and **V Conducting Human Impact Monitoring**. Sites are to be monitored for population trend, census, and human impacts on a yearly basis. Land managers agree that a decrease in the number of plants at any monitored site by 40 percent within a 2 year period will result in the cooperators reviewing all available monitoring data, evaluating possible causes of the apparent decline, and determining the most appropriate response.

After five years of data are available, the field collection data will be reviewed to determine overall population change. If large fluctuations in estimated population size, especially for significant decreases in total numbers or in the numbers of individual life

history stage classes are detected, the multi-agency team will consider developing more specific monitoring questions and applying more rigorous monitoring methods, such as demographic monitoring. If population trends appear stable or are increasing over this period of several years, the multi-agency team will consider continuing population trend with census monitoring but the frequency of monitoring will be adjusted to every 2 to 3 years rather than annually.

If monitoring data indicate that the range of the Maguire daisy is declining due to land management decisions, then actions should be taken to ensure that continued habitat loss does not threaten the Maguire daisy with extinction. Such actions include, but are not limited to, removing or reducing cattle grazing, relocating trails, installing fencing, reducing or eliminating off-highway vehicle use in the area, etc.

The Maguire daisy population could decline for a number of reasons other than loss of habitat and it will be important to consider the effects of potentially confounding factors, such as drought and environmental conditions as well as pollinator populations. Any areas identified as having a population decline will be targeted for more intensive investigation of Maguire daisy demography to determine the cause of decline. If a significant decline in abundance or survival persists for 2 consecutive years, then relisting the Maguire daisy may be considered, even if the cause of decline has not been determined.

VII. Estimated Funding Requirements and Sources

An Interagency Rare Plant Agreement established in 1999 between BLM, Capitol Reef NP, Dixie National Forest and Fishlake National Forest enabled the agencies to create an Interagency Rare Plant Team. This team works throughout the range of target species regardless of agency boundaries conducting surveys for the Maguire daisy and other rare plant species. Having an interagency team available to accomplish actions listed below is far more cost effective than having each agency hire or contract with individual botanists to complete required tasks. Therefore, costs by action (Table 2) are based on having an Interagency Rare Plant Team accomplish many of these actions. If an Interagency Rare Plant Team is not available, or utilized, to accomplish the actions listed below, cost per agency could be much greater.

Post-delisting monitoring is a cooperative effort between the Service, BLM, Capitol Reef NP, and Fishlake National Forest. Funding of post-delisting monitoring presents a challenge for all partners committed to ensuring the continued viability of the Maguire daisy following removal of protections afforded to the species under the Endangered Species Act. To the extent feasible, the Service intends to provide funding for post-delisting monitoring efforts through the annual appropriations process. Nonetheless, nothing in this PDM Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Actions will be completed as funds become

available. These actions have not been prioritized since priorities will undoubtedly change over the ten year planning period.

Table 2. Costs for Monitoring Activities.

Conservation Action	BLM Price	NPS Capitol Reef NP	Fishlake National Forest	FWS
Inventory Remaining Suitable Habitat	\$4,000			
Establish & Conduct Population Trend Monitoring Studies (includes monitoring protocol development)	\$11,000	\$11,000	\$6,500	
Establish & Conduct Impact Monitoring Studies (includes monitoring protocol development)	\$6,500			
Coordination with Center for Plant Conservation**	\$2,000	\$7,000	\$1,000	
Develop Public Awareness brochures and programs***	\$500	\$500	\$500	\$500
Estimated Database Maintenance and Report Writing	\$4,800	\$11,000	\$4,300	\$200
TOTAL BY AGENCY	\$28,800	\$29,500	\$12,300	\$700
TOTAL FOR PDM	\$71,300			

**Agencies would pursue funding to establish a Center for Plant Conservation (CPC) endowment for Maguire daisy. Maguire daisy is currently covered by the Flagstaff Arboretum for seed collection and storage only; however, it is not covered by a CPC endowment at this time. The endowment includes seed collection, creation of seed storage banks, and establishment of germination and propagation trials for the purpose of maintaining genetic conservation. This also may include research into techniques necessary for establishing additional occurrences in suitable habitat.

***The agencies would develop new partnerships with non-governmental organizations, such as native plant societies, botanical gardens, and academic institutions, etc. and continue their educational programs to increase public awareness of these and other rare plant species. Capitol Reef NP will maintain its exhibit on rare plants in their Visitor Center and continue to distribute leaflets on rare plants in the area.

VIII. Post-delisting Monitoring Implementation Schedule

Actions will be completed as funds become available and may not be completed in the years presented (Table 3).

Table 3. Monitoring Implementation Timeline.

Conservation Action	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17
Inventory Remaining Suitable Habitat											
Establish & Conduct Population Trend Monitoring Studies											
Establish & Conduct Impact Monitoring Studies (includes monitoring protocol development)											
Coordination with Center for Plant Conservation**											
Develop Public Awareness brochures and programs***											
Estimated Database Maintenance and Report Writing											

**Agencies would pursue funding to establish a Center for Plant Conservation (CPC) endowment for Maguire daisy. Maguire daisy is currently covered by the Flagstaff Arboretum for seed collection and storage only; however, it is not covered by a CPC endowment at this time. The endowment includes seed collection, creation of seed storage banks, and establishment of germination and propagation trials for the purpose of maintaining genetic conservation. This also may include research into techniques necessary for establishing additional occurrences in suitable habitat.

***The agencies would develop new partnerships with non-governmental organizations, such as native plant societies, botanical gardens, and academic institutions, etc. and continue their educational programs to increase public awareness of these and other rare plant species. Capitol Reef NP will maintain its exhibit on rare plants in their Visitor Center and continue to distribute leaflets on rare plants in the area.

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Appendix A: Data Collection Forms

Photo Plot	Species Name	Date	Survey Site	Notes/Photo #
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Rare Plant Monitoring Population Trend with Census Form
Field Definitions

Target Species

Field Name	Definition/Notes
Species Name	Enter scientific name of the target species being monitored
Plants Present?	Was the target species documented during this visit?

Site and Event Data

Field Name	Definition/Notes
Site ID #	Unique identification code for each known site. This number is generated automatically in the NCPN Rare Plant Database when a new record is created. Leave blank for newly discovered plant locations
Site Name	Enter a unique descriptive name for the site, ideally from a local place name
Visit Date	Record the date of visit as month/day/year
Time required (by person hour) to census polygon	Record number of people counting plants and how long it takes

Population Size

Field Name	Definition/Notes
Life history stage class	Seedling/Juvenile – First year plant less than 1/4 expected diameter or height of mature plants and without buds, flowers, or fruits; basal rosette of leaves without a woody base Vegetative mature – Full or nearly full-sized individual without buds, flowers, or fruits; plant has a woody taproot; may be only a basal rosette or have multiple stems Reproductive mature – Full or nearly full-sized individual with buds, flowers, or fruits Dead – non-living individual in any size class
Number of Plants	Record the actual number of plants observed by stage class

Other Data

Field Name	Definition/Notes
Plant vigor	Describe the overall health and robustness of plants in the population.
Hybrids?	Indicate whether any hybrid plants are suspected within the population. Note occurrence of any other species in the same genus as the target plant.
Biology and Herbivory Comments	Indicate approximate percentage of plants being grazed or browsed; Include other observations that are noteworthy
Human Impacts	List type and extent of impact: garbage, camping, OHV's, cattle, footprints. GPS location of each, record GPS name on field form.

Rare Plant Monitoring Photo Documentation Form

Target Species

Species Name:	Plants Present? y/n
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Site and Event Data

Site ID#	Site Name:	Visit Date:
SVA DB#	Agency:	Quadrangle:

Photo Notes: Include description (note human impacts) and bearing (deg).

Photo Type:	Camera:	Photographer:
UTM coordinates at permanent marker:		Northing:
		Easting:
Photo 1		
Photo 2		
Photo 3		
Photo 4		
Photo 5		
Photo 6		
Photo 7		
Photo 8		
Photo 9		
Photo 10		
Photo 11		
Photo 12		
Photo Comments:		

Attach map of site showing area surveyed, the permanent rebar marker, location of tracking transects and waypoints of plant locations.